

NISTTech

Microcalorimeter X-Ray Detectors with X-Ray Lens

Collects chemical composition with ease and achieves great energy resolution

Description

This X-ray microcalorimeter fits easily onto existing scanning electron microscopes and provides chemical composition information with great energy resolution. The instrument determines the chemical composition of a sample based on the energy of X-rays given off as the sample is scanned with a beam of electrons. Its improved resolution stems from the use of a superconducting detector that undergoes a rapid change in electrical resistance when heated by the absorption of a single X-ray. The instrument uses a NIST-developed mini-refrigerator that cools the detector chip to an operating temperature near absolute zero (0.1 K). Such cold temperatures are necessary to achieve high resolution, especially for lower energies.

This X-ray microcalorimeter is easy to use and detects a broad range of X-ray energies (has high energy resolution (10 to 20 electron volts)). Although the instrument will be useful to a wide range of industries, semiconductor manufacturers will be a prime first customer for the new technology. Better resolution of X-ray energies should translate into improved chemical analysis of contaminant particles in semiconductor processing, an increasingly important quality control problem as circuit dimensions continue to shrink. The NIST system fully discriminates the nearly overlapping X-ray emission spectra of silicon and tungsten important for identifying tungsten silicide, a common material in integrated circuits. It also improves identification of "light" elements such as carbon, aluminum, and silicon.

Abstract

Spectroscopic materials analysis wherein a sample under test is bombarded by electrons in a scanning electron microscope to produce an x-ray emission collected over a large solid angle by a polycapillary lens and focused onto the surface of a microcalorimeter detector. The x-ray lens is used to increase the effective collection area of the microcalorimeter detector used in an x-ray spectrometer. By increasing the collection angle, the time period for x-ray collection is reduced and the detector can be located farther from the x-ray source. The x-ray lens is effective over a broad energy range of x-rays, thus providing compatibility with spectroscopic analysis. The microcalorimeter can be calibrated to compensate for any variations in the transmission efficiency of the x-ray lens.

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References

- Expired U.S. Patent # 5,880,467
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Status of Availability

This technology is available in the public domain.

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